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ORIGINAL RESEARCH

TRANSFUSION

Barriers to blood donation on social media: An analysis of Facebook and Twitter posts

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Abstract

Background: To better understand donor behavior and ensure a safe and sufficient blood supply, various observational studies have examined barriers to blood donation. This study used Facebook and Twitter data to enhance existing research on donation barriers and associated emotions communicated on social media by both donors and non-donors.

Study design and methods: We conducted a semantic network analysis (SNA) with 168 232 public Dutch language social media messages from Facebook and Twitter during 2012–2018. SNA uses concepts as nodes in a network and the relationship (ie, co-occurrence) as links between them. We identified the relationship between donation barriers, non-donation (voluntary and involuntary), and dissatisfaction (anger and disappointment) within social media messages. This computational method was combined with an analysis examining significant relationships in-depth.

Results: Twelve donation barriers were identified: lifestyle, donation location, medical reasons, no invitation, opening times, physical reactions, pregnancy, remuneration, sexual risk behavior, time constraints, travels, and waiting times. More messages related to involuntary non-donation compared to voluntary non-donation. Involuntary non-donation was associated most strongly with medical reasons and sexual risk behavior, while voluntary non-donation was associated most strongly with resentment regarding remuneration of the blood bank's top management. Anger associated most strongly with sexual risk behavior and disappointment most strongly with medical reasons.

Conclusion: Discussions around blood donation are increasingly taking place online. Donation barriers found in this study differ from those in survey research. Insights into how donation barriers are communicated in an ever-growing online environment can be utilized to enhance recruitment and retention strategies.

Steven Ramondt and Melissa Zijlstra contributed equally to this work.

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1 | INTRODUCTION

In many Western countries the number of donors is decreasing.¹⁻³ In order to maintain a stable donor pool, a new influx of donors is essential. Moreover, retention of loyal donors is also critical.⁴ Recruitment of new donors is more cost-intensive than retention of loyal donors,⁵ safer^{6,7} and improves forecast and management of blood supply.^{8,9} Hence, it is crucial to investigate which donation barriers exist for both donors as well as non-donors.

Reasons why donors cease and non-donors do not start their donor career are traditionally derived from survey data, whereas today an opportunity exists to make use of the dramatic increase in digital data available for researchers.¹⁰ It is currently possible to mine numerous social media messages regarding blood donation. The mining of these social media messages may lead to a collection of posts that reflect the broader public's opinion and experience.¹¹ Moreover, the media environment itself may affect the perception of blood donation.¹² Social media have become an important online platform for people and organizations,¹³ and play a vital role in the Dutch recruitment and retention of blood donors. Therefore, we believe that the analysis of social media messages about blood donation has the potential to create new insights and can augment the current knowledge regarding donation barriers, thereby informing and enhancing retention- and recruitment strategies of blood collection agencies.

In survey research there is evidence that previous deferral,⁴ physical reactions,^{14,15} time constraints,¹⁶ and health-related issues (for older individuals)¹⁷ are reasons for lapsing. Medical reasons were found to be the main barrier to donate for both non-donors as well as lapsed donors.^{18,19} For blood donors who voluntarily ended their donor career, Klinkenberg and colleagues²⁰ found physical reactions to be the primary reason to stop donating.

Previous research has provided insight into the relationship between donation barriers and non-donation. However, survey research is not immune to methodological difficulties that can threaten the quality of the results, such as reactivity to the study.²¹ Respondents in a survey participate in response to an invitation to contribute to scientific research, whereas users post a message on social media for a variety of reasons (eg, to vent experiences and emotions, advise others, or help a company).²² Consequently, survey respondents are aware that they participate in research, while social media users might not be aware that their messages can be used for research purposes. It is plausible that compared to survey respondents, social media users have previously thought about the content about which they post, and posts can contain a richness that is hard to collect in a survey.¹¹ Moreover, social media messages are not restricted to certain answer

categories—in contrast with survey studies—and can therefore reveal new donation barriers not previously assessed by surveys. By studying donation barriers with social media data, in which data originate in a more organic manner, we aim to identify which barriers lead to non-donation in both donors as well as non-donors. We expect the nature of social media data (eg, big, rich, and always on) and the difference between survey responses and online messages in limitations (eg, participation- and social-desirability bias) to supplement current research on donation barriers.^{11,21,23}

The goal of the present study is to explore which barriers are related to non-donation and dissatisfaction in online messages on Facebook and Twitter in order to inform and ultimately enhance retention and recruitment strategies. Because donors can decide to stop on their own, and (potential) donors can be prevented to donate by the blood service, we distinguished between voluntary non-donation and involuntary non-donation. In addition, we investigate which donation barrier elicits dissatisfaction, in the form of anger and disappointment. We take into consideration anger and disappointment as these emotions are often expressed by those who are prevented from donating.²⁴ Moreover, these are the emotions that consumers in general elicit when confronted with negative experiences and are often expressed on social media.²⁵⁻²⁷

2 | MATERIALS AND METHODS

2.1 | Data collection

We studied Dutch social media to explore which motives are related to non-donation and dissatisfaction in online messages. Dutch blood collection is performed by a monopolistic blood collection agency (Sanquin), where all blood donors donate on a voluntary basis and are not compensated. Online messages were collected through Coosto (www.coosto.nl), a widely used social media tool with an extensive social media database. We applied a search string, similar to the process of finding literature for a literature review, including various (combinations of) terms related to blood donors, blood donations, and blood collection agencies (see Appendix A, Table A1). Messages from 1 January 2012, the year that Dutch social messages related to blood donation started to rise rapidly, until 31 December 2018 were collected. The messages were then imported in AmCAT (Amsterdam Content Analysis Toolkit), an online tool which allows for the management of content analysis projects and conducting keyword-based analyses to find relevant messages in a dataset.²⁸ We limited our dataset to public posts on the two largest social media platforms on which Sanquin is

most active (and contain most messages about blood donations and blood collection agencies): Facebook and Twitter. Our study focuses on non-donation expressed online by the general public—including donors as well as non-donors—and therefore messages from blood collection agencies were removed. In addition, duplicates, irrelevant topics (eg, illegal blood transfusions in cycle racing) and media platforms other than Facebook or Twitter (eg, blogs, Instagram) (see Appendix A for the removal keywords) were also removed from the dataset.

2.2 | Study variables

Based on prior research by Duboz and Cuneo,¹⁹ Wevers et al.,¹⁶ and Klinkenberg et al.,²⁰ we created a list of donation barriers. This list was supplemented with donation barriers that were experienced as important by the blood collection agencies' staff, received a lot of (traditional) media attention, and by assessing a subsample of the social media messages to identify common donation barriers. Two donation barriers that supplemented the list

from the literature deserve additional clarification. First, the remuneration of the blood bank's top management received a lot of (traditional) media attention.²⁹ Due to the conflict between the (former) financial compensation of certain members of the board of directors of Sanquin and the voluntary and non-compensated nature of blood donation in the Netherlands. Second, sexual risk behavior primarily captures the exclusion of men who have sex with men (MSM), a policy that has been perceived as highly controversial.³⁰ It is also important to note that involuntary non-donation includes the permanent exclusion from donation, as well as temporary prevention from donation (eg, a 3-month deferral due to low Hb). In total, twelve donation barriers were included, see Table 1.

To identify our variables of interest (ie, donation barriers, non-donation, and dissatisfaction), we relied on concrete search strings (see Appendix A, Table A2). Based on the procedure described in Stryker et al.,³¹ search strings were developed following an iterative process of adding and removing keywords and inspecting the results. Precision of the search strings was calculated by dividing the number of correct results (ie, hits that

TABLE 1 Overview variables of interest

Variable	Hypothetical message examples ^a
Non-donation	
Voluntary non-donation	Was a blood donor, but I will not be back until the blood donation location in the village comes back.
Involuntary non-donation (includes deferral)	I would like to donate but my Hb needs to rise before I can donate.
Dissatisfaction	
Anger	The time of aids is over, it is ridiculous that gays cannot donate blood.
Disappointment	When I finally had the courage to donate blood, I was rejected immediately. Unfortunate!
Donation barriers	
Donation location (distance/closed)	Less blood is needed, so they closed locations. How is it possible that they are always calling to come?
Lifestyle (eg, lack of time, taking drugs or a tattoo)	Oops! Didn't know you could not donate after getting a tattoo.
Medical reasons	No blood donation due to low iron ...
No invitation (ie, not receiving an invitation to donate)	Never get a call ... no need for B-?
Opening times	Standing in front of the blood bank ... is only open tonight due to holidays. Really?
Physical reactions	Very sore arm due to my donation. Worth it!
Pregnancy	Cannot because of pregnancy, but I expect to be back soon!
Remuneration (of blood bank's top management)	Why do blood bank directors have top salaries while we provide free blood?
Sexual risk behavior (men who have sex with men)	You have been asking for it for years, and I would like to donate, but you exclude homosexuals.
Time constraints	Is it possible to donate in the weekend, I have no time during the week.
Travels (to malaria endemic areas)	No blood, because I lived in a malaria area for over 8 months.
Waiting times	Going to donate some blood at the #bloodbank. Have to wait long, very busy.

^aDue to privacy reasons, no actual messages could be used as an example. However, the examples are based on existing Dutch messages.

relate to the topic of interest) by the sum of correct and incorrect results (ie, hits unrelated to the topic of interest) using a random sample of 50 messages per search string. The excellent mean precision was 0.84 (range 0.62-1.00) and met our a priori goal of 0.6 (see Appendix A, Table A3 for full precision table).³¹

2.3 | Data analysis

Utilizing a semantic network analysis (SNA) conducted in AmCAT, we examined the relationship between donation barriers, non-donation (voluntary and involuntary), and dissatisfaction (anger and disappointment) within Facebook and Twitter messages. SNA uses words or concepts as nodes in a network and the relationship (in the form of co-occurrence) as links (edges) between them. Organizing text into networks through SNA makes it possible to turn the large amount of social media messages into manageable and efficient graphical representations.³² Asymmetric conditional probabilities were calculated to identify the relation (co-occurrence) and are illustrated as: $p(B|A)$. A conditional probability indicates the chance that when a social media message contains

concept A, it also contains concept B. For example, $(p(\text{Sexualriskbehavior}|\text{Anger}))$ indicates the likelihood that when a social media message contains anger, it is about sexual risk behavior.

We visualized the conditional probabilities between our concepts in terms of a network. To reduce the *complexity* of the figure, we expressed probabilities in percentages and did not visualize weak conditional probabilities. We defined a weak conditional probability as being smaller than 0.05 (ie, <5% of the messages about concept A contain words from concept B). Therefore, an arrow is drawn from concept A to concept B only if the conditional probability reaches a minimum of 0.05, ie, 5%. The lack of visualization does not indicate that no relationship exists, or that conditional probabilities below 0.05 are statistically irrelevant (see Figure 1 for an overview of all probabilities). In addition, we only visualize arrows from non-donation or dissatisfaction to donation barriers as we are interested in the relationship between messages related to non-donation/dissatisfaction and donation barriers (ie, the probability that donation barriers are discussed when the message is about non-donation or dissatisfaction), and not general information about the donation barriers themselves. Similarly, we only visualize arrows from non-donation to dissatisfaction,

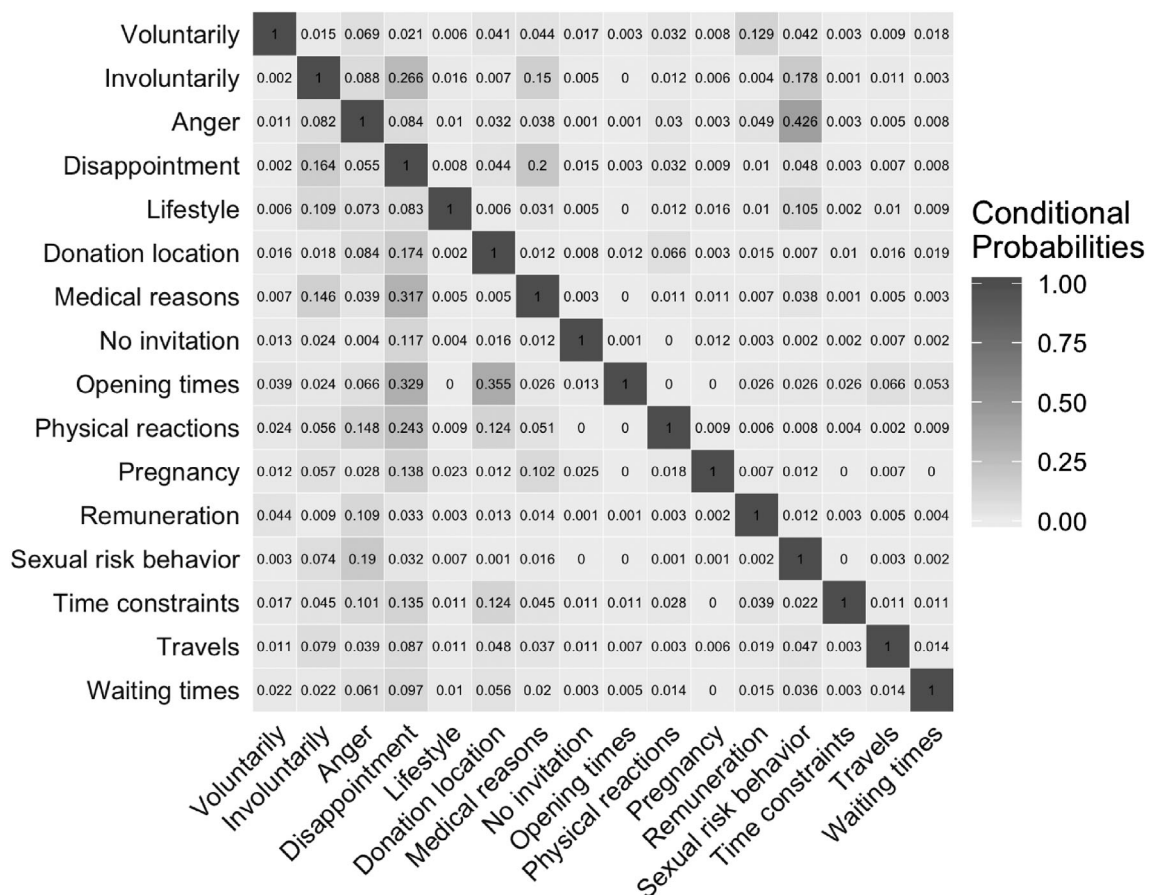


FIGURE 1 Overview of conditional probabilities. Displays the relationship (co-occurrence) of all variables included in the study. Darker color corresponds to a higher probability

since we are interested in the probability of dissatisfaction in a message about non-donation.

An example of such a network is illustrated in Figure 2. It contains two donation barrier variables and the variable voluntary non-donation. Due to the use of conditional probabilities to identify the relationship between variables and reduction in figure complexity (see above), the networks in this figure (and other figures in this paper) can be read as separate dyads. The example network contains two dyads: donation barrier 1 with voluntary non-donation, and donation barrier 2 with voluntary non-donation. No connection (outside of being both related to the variable voluntary non-donation) with a probability $\geq .05$ exists between donation barrier 1 and donation barrier 2. The network in the example figure can be interpreted the following way; the likelihood that donation barrier 1 is mentioned in a message about voluntary non-donation is 16.9%, and the chance that donation barrier 2 is mentioned in a message about voluntary non-donation is 10.5%. Put differently, there is a 10.5% chance that a message related to voluntary non-donation will also contain a word related to donation barrier 2.

Going beyond the computational network analysis, we decided to take a qualitative step and randomly sampled 50 messages of all donation barrier relationships that had a conditional probability of $\geq .05$ to co-occur with non-donation or dissatisfaction. Here we gauged if the message was relevant (ie, the message was actually about the relationship between a donation barrier and non-donation or dissatisfaction). In addition, we assessed if donation barriers affect the writer of the social media

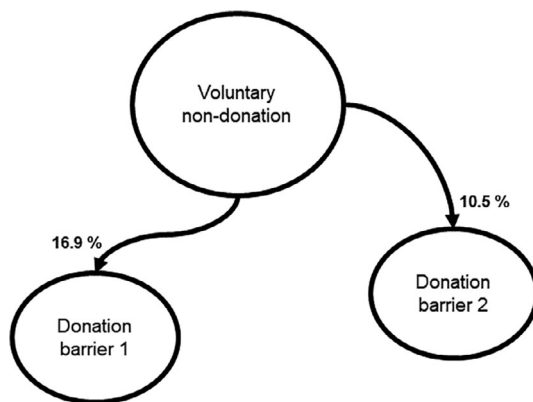


FIGURE 2 Association graph of donation barriers and voluntary non-donation

message personally, or if there is an issue with policy that is responsible for the barrier. Furthermore, we examined if the donation barrier resulted in self-reported ceasing of the donor career, and if a person defended Sanquin's policy. Lastly, we investigated if the message contained links to other media (including news websites), as it is possible that intermedia agenda setting takes place in which non-donors comment on social media primarily about topics covered in other (news) media in contrast to the real experiences expressed by donors.³³

3 | RESULTS

3.1 | Social media messages

The final dataset contained a total of 168 232 messages. Our data indicated a nearly even divide of messages about blood donations and blood collection agencies between Twitter (N = 85 437) and Facebook (N = 82 795). Almost 40% (N = 64 893) of messages in our dataset were found on the Facebook page of Sanquin (N = 30 019), or the Sanquin Twitter account (N = 34 874). Table 2 shows the number of messages included in our dataset for each year. The number of messages about blood donations and blood collection agencies has increased since 2012 (N = 16 656), with 27 772 messages in 2018 and peaking in 2016 (N = 32 564).

3.2 | Donation barriers

Almost 11% (N = 18 274) of all messages about blood donations and blood collection agencies were about non-donation and/or dissatisfaction. As can be seen in Table 3, more messages contained words related to involuntary non-donation (N = 5355) compared to voluntary non-donation (N = 887). Messages related to dissatisfaction were prevalent, with more messages that contained words related to dissatisfaction (N = 8703) compared to anger (N = 5732). Sexual risk behavior (N = 12 873), medical reasons (N = 5500), and remuneration of blood bank's top management (N = 2584) were the most discussed donation barriers on social media.

When looking at the differences between medium, we see that 56.6% of all messages containing variables of interest are from Facebook, and 43.4% of all messages containing variables of interest were from Twitter. The

TABLE 2 Social media messages

	2012	2013	2014	2015	2016	2017	2018	Total
N (%)	16 656 (9.9)	17 056 (10.1)	19 628 (11.7)	26 570 (15.8)	32 564 (19.4)	27 986 (16.6)	27 772 (16.5)	168 232 (100)

TABLE 3 Overview operationalized concepts: non-donation, dissatisfaction, and donation barriers

	Messages	Facebook		Twitter	
		Messages	%	Messages	%
Non-donation					
Voluntary non-donation	887	627	70.7	260	29.3
Involuntary non-donation	5355	3797	71.0	1558	29.1
Dissatisfaction					
Anger	5733	2562	44.7	3171	55.3
Disappointment	8703	7547	86.7	1156	13.3
Donation barriers					
Donation location	2197	1273	58.0	924	42.1
Lifestyle	810	520	64.2	290	35.8
Medical reasons	5500	4078	74.1	1422	25.9
No invitation	1133	1022	90.2	111	9.8
Opening times	76	55	72.4	21	27.6
Physical reactions	1159	826	71.3	333	28.7
Pregnancy	566	468	82.7	98	17.3
Remuneration	2584	957	37.0	1627	63.0
Sexual risk behavior (MSM)	12 873	3263	25.3	9610	74.7
Time constraints	178	94	52.8	84	47.2
Travels	722	425	50.9	297	41.1
Waiting times	732	342	46.7	390	53.3
Total, N	49 207 ^a	27 856	56.6	21 351	43.4

^a38 293 unique messages.

majority of messages about non-donation were found on Facebook (voluntary = 70.7%, involuntary = 71.0%). In addition, we saw disappointment was expressed most on Facebook (86.7%), while anger was expressed most on Twitter (55.3%). Similarly, we saw that most donation barriers were found on Facebook, with the exception of sexual risk behavior (25.3%), remuneration of the blood bank's top management (37.0%), and waiting times (46.7%). A little over a third of all messages about involuntary non-donation (N = 320) and voluntary non-donation (N = 1974) were posted on the official Sanquin Facebook page or mentioned the Sanquin Twitter account. Similarly, 31.0% (N = 1662) of all angry messages and 40.0% of all disappointed messages were posted on an official Sanquin account.

3.3 | Semantic network analysis

Figure 3 visualizes the relation between the variables (ie, non-donation, dissatisfaction, and donation barriers) in a network, based on the asymmetric conditional probabilities (also see Figure 1). The probability that a donation barrier was mentioned in a message about voluntary non-donation was

highest for messages about remuneration of the blood bank's top management ($p(\text{Remuneration}|\text{Voluntary}) = 0.129$). Medical reasons ($p(\text{Medical}|\text{Voluntary}) = 0.044$), sexual risk behavior ($p(\text{Sexualriskbehavior}|\text{Voluntary}) = 0.042$), and donation location ($p(\text{Location}|\text{voluntary}) = 0.041$) were less frequently mentioned in messages about voluntary non-donation. Sexual risk behavior ($p(\text{Sexualriskbehavior}|\text{Involuntary}) = 0.178$) and medical reasons ($p(\text{Medical}|\text{Involuntary}) = 0.150$) were the primary donation barriers mentioned in messages about involuntary non-donation. Both voluntary non-donation ($p(\text{Anger}|\text{Voluntary}) = 0.069$) and involuntary ($p(\text{Anger}|\text{Involuntary}) = 0.088$), related to "angry" messages. However, disappointment was the emotion that was most strongly associated with involuntary non-donation ($p(\text{Disappointment}|\text{Involuntary}) = 0.266$).

With regard to dissatisfaction, we saw that sexual risk behavior ($p(\text{Sexualriskbehavior}|\text{Anger}) = 0.426$) was the primary donation barrier brought up in angry messages, with remuneration of the blood bank's top management ($p(\text{Remuneration}|\text{Anger}) = 0.049$) mentioned occasionally. Medical reasons ($p(\text{Medical}|\text{Disappointment}) = 0.200$) were emphasized in messages about disappointment. Both sexual risk behavior ($p(\text{Sexualriskbehavior}|\text{Disappointment}) = 0.048$) and donation location ($p(\text{Location}|\text{Disappointment}) = 0.048$) were also mentioned in messages about disappointment.

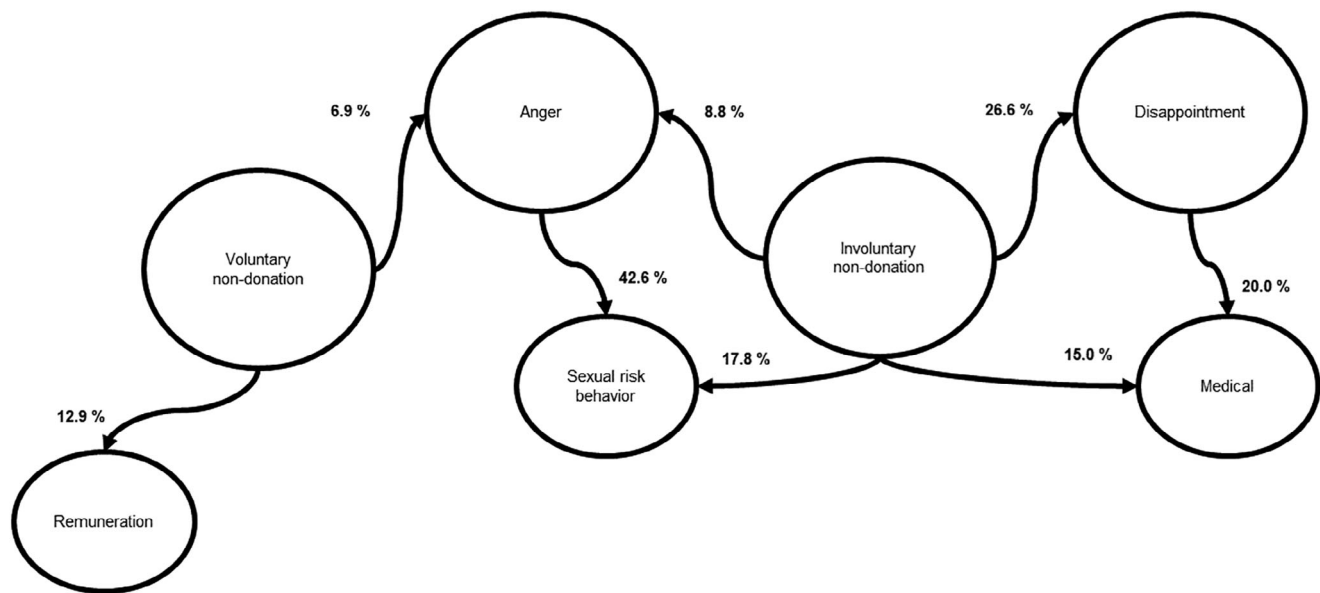


FIGURE 3 Association graph of non-donation (voluntary and involuntary), dissatisfaction (anger and disappointment), and donation barriers

Disappointment) = 0.044) were less frequently mentioned in messages about disappointment.

3.4 | Qualitative analysis

Three donation barriers (ie, remuneration, medical reasons, and sexual risk behavior) had a conditional probability of $\geq .05$ to co-occur with non-donation or dissatisfaction. These three donation barriers were analyzed more in-depth in a qualitative step.

The majority ($N = 46$) of a random sample of 50 messages was relevant, meaning that they contained the relationship between voluntary non-donation and remuneration. Of these relevant messages, 37 were personal messages, about personal impact/actions. Almost all the personal messages discussed the writer ceasing ($N = 31$) or threatening ($N = 5$) to cease their donor career. Only one message contained a media source. Similarly, most of the messages about involuntary non-donation and medical reasons ($N = 47$) were relevant, and the majority of the relevant messages were about a personal impact ($N = 44$). In these messages people expressed that they were not allowed to donate. Only three messages were about the policy of Sanquin forcing a person to stop donating blood, and all three messages defended the policy. All the messages about involuntary non-donation and sexual risk behavior were relevant. Only 14 messages were about a personal impact. Thirty-six of the messages were about policy with three messages discussing that they stopped donating blood, and three messages defending the policy. Furthermore,

10 messages had a media source, with six of them only sharing the media messages without adding anything.

Nearly all ($N = 49$) of the messages about anger and sexual risk behavior were relevant. Only four messages were from a personal impact perspective, 45 messages included angry terms about the policy from a non-personal perspective. Four messages discussed ceasing their blood donor career because of the policy and five messages defended the policy. Almost half of the policy messages ($N = 24$) had a media source and 12 of those shared the media messages without adding anything. Similarly, most ($N = 48$) of the messages about disappointment and medical reasons were relevant and over half of them ($N = 26$) were about a personal impact. The other 22 messages involved the sharing of a message to recruit new donors because the initial person could not donate for medical reasons.

4 | DISCUSSION

The aim of the present study was to review and analyze donation barriers, non-donation, and dissatisfaction regarding blood donations and blood collection agencies utilizing nearly 170 000 online messages on Facebook and Twitter. To our knowledge, this is the first analysis of social media messages in the field of blood donation and transfusion. The present study contributes to prior research by differentiating and examining both voluntary and involuntary non-donation. The results in this study show that remuneration of the blood banks' top management is the most mentioned donation barrier in Dutch

public social media messages about blood donations and blood collection agencies. Sexual risk behavior and medical reasons were the donation barriers that evoked the most emotion and associated most strongly with involuntary non-donation.

The association between involuntary non-donation and medical reasons is in line with previous work that identified medical reasons as main barrier to donate for both non-donors and lapsed donors.^{18,19} Similarly, Klinkenberg et al.²⁰ noted that a sizeable part of their sample reported to be not eligible for blood donation due to medical reasons. However, the strong association between sexual risk behavior and involuntary non-donation is a novel finding. Here, it is important to differentiate between donors and non-donors. Our sampled messages showed that medical reasons for involuntary non-donation primarily contained personal stories about people no longer (or not) eligible for blood donation. Only a small part of the sampled messages about sexual risk behavior were about donors discussing the end of their donor career. The majority of the sampled messages concerning sexual risk behavior were about the blood bank policy regarding sexual risk behavior and associated deferral, and not personal experiences, indicating that sexual risk behavior might primarily be a donation barrier that is discussed by non-donors on social media.

In the messages about voluntary non-donation, remuneration of the blood bank's top management was the most frequently mentioned donation barrier. Moreover, the majority of the sampled messages (self-) reported ceasing their donor career because of remuneration of the blood bank's top management, indicating that this is an important barrier for donors to continue their donor career. However, the discussion around remuneration of the blood bank's top management might be unique to the Netherlands. Medical reasons, sexual risk behavior, and donation location were other donation barriers occasionally mentioned in messages about voluntary non-donation. This is in contrast with other studies that found time constraints and physical reactions to be the primary donation barriers.^{16,20}

Medical reasons were most strongly associated with disappointment. This is not surprising because people might want to openly communicate that their good intention to donate blood is impeded by a medical reason. Furthermore, this impediment is often an uncontrollable event where expectations about donating blood are not realized, which can lead to expressions of disappointment to warn others.³⁴ Sexual risk behavior, a blood bank policy related topic, evoked strong emotions of anger. Sexual risk behavior as a reason for exclusion, especially the exclusion with regards to men who have sex with men has been perceived as controversial³⁰ and is debated in

the media in a negative way. By associating this policy related donation barrier (ie, sexual risk behavior) to non-donation people might attempt to encourage an organization to improve its practices.³⁵ Some of our results indicated possible intermedia agenda setting. Nearly half of the messages about anger and sexual risk behavior had a media source expressing anger about the MSM exclusion policy and a quarter only shared this media message without any other contribution.

The discrepancy between our study results and the results in survey studies might be explained by our limited ability to differentiate between social media messages from donors and social media messages from non-donors. Donation barriers might differ between non-donors and donors and this could explain the predominance of policy related donation barriers and lack of typical donation barriers such as time constraints and physical reactions in social media messages. Other differences between survey research and social media research as mentioned in the introduction could explain discrepancies as well. For example, the lack of association between physical reactions and non-donation can be explained by social desirability bias. Ceasing a donor career because of physical reactions, such as pain or fainting, might leave donors feeling ashamed. The open nature of social media, in which messages are visible to their own network and sometimes even the general public, could stimulate creators of social media messages to censor themselves in order to avoid embarrassment. Furthermore, social desirability bias might push people to report less on individual donation barriers and more on external causes that are outside a person's control. Ambiguous operationalization can also plausibly explain the lack of association found in our study between non-donation and time constraints as the operationalization in previous research, ie, "donor who could not donate and did not give an explicit barrier" (p. 39, Table 1.),¹⁶ is likely to not be an accurate measure for time constraints.

This study shows some discrepancies with prior research and should be seen as an addition to the current literature. Regardless of the (expected) discrepancies with other studies, it is important for blood collection agencies to take note and act on the donation barriers expressed online. This is especially salient since our study shows that non-donation and dissatisfaction represent a sizeable part of the growing volume of public Dutch social media messages on blood donation and blood collection agencies found online. Furthermore, people seem to trust and pay more attention to negative- than positive information,^{36,37} and to information coming from peers rather than from institutions,³⁸ making the current online environment both a threat to and an opportunity for a stable donor pool.

Despite the contributions to the current knowledge on donation barriers, this study also has some limitations beyond the ones discussed above. First, it is impossible to irrefutably identify if a person who made a social media post about blood donation ever actually donated blood with the data we used in this study. Second, due to the large number of messages in our dataset and inclusion of concepts with a relatively small number of messages, it was not feasible to estimate recall (conditional probability that a text related to the concept will be included).³¹ Lastly, the asymmetric conditional probabilities were calculated on an aggregate level data over an extended period of time. Therefore, we did not identify changes in the relationships over time, and changes in the measurement system (eg, changes in certain messages over time because specific demographic populations stopped using Facebook) might have happened. Future studies that have access to more data should better implement time as a factor to investigate the relationship between donation barriers and non-donation.

In conclusion, our results give insight into the way donation barriers are communicated in an ever-growing online environment. With these results, the study contributes to prior research on donation barriers and illustrates the benefit of utilizing different methods on the same topic. The insights gained from this study can be implemented in recruitment and retention strategies—especially strategies through social media—in which messages can be tailored to address the significant donation barriers revealed.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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APPENDIX A: LUCENE SEARCH STRINGS AND PRECISION

TABLE A1 Search string to acquire article selection and clean data

Blood donations & blood bank	Bloeddon* OR plasmadon* OR ((bloed OR plasma) NEAR(3) (donor* OR donatie OR doneren OR gedoneerd OR geven OR gegeven OR schenken OR geschenken)) OR bloedbank OR sanquin OR (sanguin OR #bloedbank OR #bloeddonatie OR #bloeddoneren OR #bloeddonor OR #bloeddonordag OR #bloeddonoren OR #bloeddonors OR #bloedgeven OR #bloedgevendootleven OR #bloedisleven OR #bloedplasma OR #bloedvoorziening OR #bloeddonation OR #bloeddonor OR #geefbloed OR #ikgeefbloed OR #plasmadonatie OR #plasmadonor OR #wereldbloeddonordag OR #worldbloeddonorday OR missingtype) OR site:www.Facebook.com/sanquin OR site:instagram.com/sanquin/ OR site:Twitter.com/sanquin OR @sanquin
Removal of irrelevant messages	NOT(doping* epo* "ronde van Frankrijk" "Tour de France" Rabo* "Thomas Dekker" "Rasmussen" "Michael Boogerd" "Midden Oosten" Syrië* Libië Iran* Irak* Turk* Egypte* Jeruzalem Liban* Palest* Jordanië Afgha* Arab* Hamas Egypte* Marokko Hezbollah "Muslim Brotherhood" Assad "Bin Laden" terror* terreur* moslimextremist* extremist* Allah islam* ISIS* Qaida Kalifaat dictator* dictatu* shari* PKK YPG dodental* onthoofd* verkracht* moord* burgeroorlog* schietpartij* oorlog* bombardement* explosie* gevechtsvliegtuig* straaljager* ontploffing* geëvacueerd evacuatie* treinramp* ramptrain* treinongeluk vliegkamp* vliegtuigkamp vliegongeluk* vliegtuigongeluk* crash aardbeving* orkaan* natuurramp* tornado* cycloon* wrakstuk* rookwolk* brandweer* vacature* CV sollicit* motivatiebrief* elektronica* "pc game*" "pc spel*" computerspel* gamificati* game* playstation* Xbox* PS4 software* hardware* bloodborne "open dag" "Rode Kruis Vlaanderen" "Q koorts" dieren* paard* veulen* kip* kuiken* koe* kalf* kalveren konijn* kat* poes* poezen hond* geit* schaap* "werken bij" werkbezoek* "rode kruis" Vlaanderen mug* insect* Genk antwerpen mechelen belgie Ronaldo jehova jehova religie christus bijbel "onze Here" amen hemel islam* "lavandel" "god* zoon" "tawheed" "hellevuur" "amazing spiderman" "brand" creator:"Veterinair Quadrant" creator:"Donorkinderen België" creator:"Eerste Veterinaire Bloedbank Nederland" creator:"Dierenziekenhuis

TABLE A1 (Continued)

Zeeuws-Vlaanderen" creator:"Blood Banks" creator:"Stichting Matchis voorheen
 Europdonor" creator:"StichtingYorkie" creator:"De grote strijd tussen Christus en Satan"
 creator:"VacaturesLeiden" creator:"VacatureGezond" creator:"VastgoedjobNL"
 creator:"vacature_jobs" creator:"joofvacatures" creator:"Collegaegezocht"
 creator:"Gezondheidszorg Vacatures" creator:"VacaturesAmste2"
 creator:"amsterdamvacant" creator:"VacatureWerk" creator:"VacatureBaan"
 creator:"werkvacatures" creator:"gratisvacatures" creator:"NLzoektwerk"
 creator:"HBOWO_vacatures" creator:"vacaturewijzer" creator:"NeuvooAmsterdNL"
 creator:"Stadvacature" creator:"JobsToday_nl" creator:"vacaturestream1"
 creator:"VacatureTechnic" creator:"AmsterdamBaan" creator:"BanenJobs"
 creator:"Marketing & Communicatie Vacatures" creator:"YER_Jobs" creator:"Amsterdam:
 Werken & Vacatures" creator:"amsterdamwerken" creator:"TopVacaturebank"
 creator:"vacatures_nrl" creator:"Werkgever-vacatures.nl" creator:"Werkgevers_nt"
 creator:"Islam De Ware Godsdienst" creator:"020_vacatures"
 creator:"Amsterdamvacaturebank" creator:"AmsterTechniek" creator:"banen.nu"
 creator:"gezondheid_vc" creator:"DagVacatures" creator:"Rode Kruis-Vlaanderen"
 creator:"RodeKruisVL" creator:"BloedGevenDoetLeven" creator:"rodekruisvlaanderen"
 creator:"RodeKruis_StJob" creator:"RodeKruis Kruis Afdeling Oudenburg-Jabbeke"
 creator:"Rode Kruis Mechelen-Bonheiden" creator:"Bloedserieus Leuven"
 creator:"BLOEDSERIEUS" creator:"BloedserieusVB" creator:"Het Surinaamse Rode Kruis"
 creator:"Rode Kruis-Puurs" creator:"Rode Kruis-Bredene" creator:"Rode Kruis-Herentals"
 creator:"RodeKruis" creator:"Rode Kruis-wevelgem" creator:"Rode Kruis Halle"
 creator:"Bloedserieus Gent" creator:"RodeKruisHassel" creator:"rodekruispuurs"
 creator:"Rode Kruis - Leuven" creator:"Rode Kruis Ingelmunster" creator:"Rode Kruis
 Merksem" creator:"Rode Kruis - Duffel" creator:"Rode Kruis - Haacht"
 creator:"rodekruisbrakel" creator:"Rode Kruis-Opwijk" creator:"R_deKruisVL"
 creator:"Rode Kruis-Overijse" creator:"Rode Kruis Hoeselt" creator:"RodeKruisDmonde"
 creator:"Rode Kruis Kuurne" creator:"Rode Kruis - Leuven" creator:"Rode Kruis-
 Buggenhout" creator:"Rode Kruis Hamme" creator:"Rode Kruis-Blankenberge-Zuikerkerke"
 creator:"Rode Kruis-Wevelgem" creator:"Bloedgevendoeleven Sint-Truiden" creator:"Bloed
 Geven Riemst" creator:"Bloedgeven Westrozebeke" creator:"Bloedgeven Keiem - Leke"
 creator:"Rode Kruis-Dendermonde" creator:"Rode Kruis Sint-Truiden" creator:"Rode Kruis
 Diest" creator:"Rode Kruis-Maasmechelen" creator:"Rode Kruis Wijnegem-Deurne"
 creator:"Rode Kruis-Olen" creator:"Rode Kruis Leopoldsburg" creator:"RodeKruisLeuven"
 creator:"Rode Kruis - Oud-Turnhout" creator:"Transfusia" creator:"Vrijwillige Bloedgevers
 Baarle" creator:"Rodekruis Houthalen" creator:"Rode Kruis" creator:"Rode Kruis
 Hoogstraten" creator:"Rode Kruis Zele" creator:"Stichting Rode Kruis Bloedbank Curacao"
 creator:"Rode Kruis-Herenthout" creator:"RodeKruisPuurs" creator:"Bloed Geven
 Harelbeke" creator:"Rode Kruis Diepenbeek" creator:"rodekruisbmrst" creator:"Rode
 kruis oostrozebeke" creator:"Rode Kruis Ruisbroek" creator:"Rode Kruis Landen"
 creator:"RodeKruisGent" creator:"Rode Kruis-Gent" creator:"Rode Kruis Oudenburg-
 Jabbeke" creator:"Rode Kruis Wielsbeke" creator:"RodeKruisDiest"
 creator:"RodeKruisHalle" creator:"Rode Kruis-Groot-Kortrijk" creator:"Rode Kruis-
 Zuiderdistrict" creator:"Jeugd Rode Kruis Lanaken" creator:"Rode Kruis Sint-Job"
 creator:"Rode Kruis-Oud-Turnhout" creator:"Rode Kruis Grobbendonk-Vorselaar"
 creator:"Bloedinzamelingen Tessenderlo" creator:"RodeKruisZele"
 creator:"RodeKruisLeoHep" creator:"Rode Kruis-Malle" creator:"Rode Kruis - Hasselt"
 creator:"Rode Kruis Zelzate" creator:"Rode Kruis Westerlo" creator:"RodeKruisGeel"
 creator:"RodeKruisVL_" creator:"RodeKruisTienen" creator:"RodeKruisMeBo"
 creator:"Jeugd Rode Kruis - Leuven" creator:"Bloedgevers uit Sint-Job" creator:"Bloedgevers
 Stevoort" creator:"RodeKruisGistel" creator:"TeamleaderBE" creator:"HLN.be"
 creator:"RedCrossBloodCA" creator:"Sanquin" creator:"sanquin" creator:"Sanquin
 Bloedvoorziening" creator:"sanquinwerkt" creator:"Stichting Sanquin" creator:"Sanquin
 Bloedbank" creator:"Sanquin Bloedvoorziening Breda" creator:"SanquinNL"
 creator:"SanQuin")

TABLE A2 Search string to operationalize concepts

Non-donation	<p>Voluntary# (“mee stop*” “te stop*” “ik stop*” “stop* ik” gestop* opzeg* beëindig* opgehoud* “houd het op” ~ 2 terugtrekken “terug getrokken” “terug te trekken” afhaken afgehaakt “haak af” ~ 3 “er klaar mee” ~ 3 “geen donor meer” ~ 3 “geen bloeddonor meer” ~ 3 “geen donatie* meer” ~ 3 “geen bloeddonatie meer” ~ 3 “doneer niet meer” ~ 3 “geef niet meer” ~ 3 “geef geen meer” ~ 3 “doneer geen bloed meer” ~ 3 “doe niet meer” ~ 3 “wil niet meer” ~ 3 “ga niet meer” ~ 3 “niet meer doneren” ~ 3 “ga niet meer geven” ~ 3 “niet meer afstaan” ~ 3 “niet meer afgeven” ~ 3 uitgeschreven) NOT (“mag niet” ~ 3 OR “mag geen” ~ 3 OR “moe* stoppen” ~ 3 OR helaas OR jammer OR nachtmerrie OR “#kinopolis” OR mogen OR mocht* OR “advies gestop*” ~ 3 OR “advies stop*” ~ 3) Involuntary# geweiger* afgewezen afwijzing afgekeurd afkeuring “mocht niet” ~ 3 “ik mag niet” ~ 3 uitgesloten “mag geen donor” “mag geen bloed” “mag geen donatie” “mocht geen donor” “mocht geen bloed” “mocht geen donatie” “mocht geen donor” weggestuurd “weg gestuurd” “naar huis gestuurd” “terug gestuurd” “wil mijn bloed niet” “mag niet meer” “mag geen bloeddonor” “moe* stoppen”</p>
Dissatisfaction	<p>Anger# chagrijnig teleur* kots* belachelijk* absurd* dwaas dwaz* bespottelijk achterlijk gestoord* zot schandalig* onnozel bizar* pissig schande erger* irrit* stom* onzin* kul nonsens gelul lulkoek flauwekul blamage waardelo* ongelo*elijk* ongeloof* “geen vertrouwen” ~ 3 wantrouw* “vertrouw* niet” ~ 3 onbegrip onbegrijp* bullshit “bull shit” discrimin* “slaats nergens op” boos boosheid boze* woedend* “ben kwaad” ~ 3 imbeciel* debiel* mongol* mongool* kloot* klote mafkees mafkez* dwaas dwazen geldwolv* “zakken vullen” “zakkenvullers” kut* fuck* fuk* fack* fak* fock* fok* godver* verdom* tering* schijt* reet “rot op” oprotten “donder op” opdonderen “flikker op” opflikkeren opzouten oplicht* tijdverspil* klagen klacht “niet blij” fail faalt frustreren* frustratie “heeft niets te maken” ~ 2 “bloedlink” Disappointment# “niet leuk” “niet mee eens” oneens vervelend “vond verschrikkelijk” ~ 2 “vind vreselijk” ~ 2 “vond vreselijk” ~ 2 balen baal zonde jammer* helaas* betreurenswaardig* spijtig “pijn in hart” ~ 2</p>
Donation barriers	<p>Physicalreaction# “dunne ader*” “lang herstel*” ~ 4 “zenuw geraakt” “verkeerd geprikt” “bon? en blauw” “naast prikken” misprik* misgeprik* flauwval* flauwgevallen “blauw* plek*” duizelig* “licht in hoofd” ~ 2 “van stok* gaan” ~ 3 “van stok* gegaan” ~ 3 “slecht prikken” ~ 3 “moeilijk prikken” ~ 3 “niet goed prikken” ~ 3 “zere rechterarm” “zere arm” “pijn* arm” ~ 2 beroerd misselijk* braken “niet lekker geworden” “werd niet lekker” ~ 2 “deed zeer” ~ 3 “valt flauw” ~ 2 “voel naald*” ~ 2 “last van naald*” ~ 3 “naald* niet goed” ~ 2 Medical# hb* bloedarmoede* anemie* hemoglob* ijzer* onsteking* gewicht* “te licht” “50 kg” “50 kilo*” “vijftig kg” “vijftig kilo*” “bloeddruk te hoog” “bloeddruk te laag” “door ziekte” “transfusie gehad” ~ 3 “bloedtransfusie gehad” ~ 3 “zelf bloed gekregen” ~ 3 “zelf bloed ontvangen” ~ 3 “70 jaar” “te oud” “te jong” antibiotica bloedaafwijking diabetes epilepsie pfeiffer stollingsziekte “Creutzfeldt Jakob” trombose gordelroos infectie* Pregnancy# zwanger* bevalling* borstvoeding* NOT (na?elstreng*) Travels# malaria* tropen* tropisch* reiz* reis risicogebied* zomervakantie* (buitenland* AND (Virus OR infecti* OR “niet bloed” ~ 3 OR “geen bloed” ~ 3)) (vakantie* AND (Virus OR infecti* OR “niet bloed” ~ 3 OR “geen bloed” ~ 3)) Lifestyle# tatto* getatt* pierc* gepierc* drug* coke cocain* Location# lo?atie* afnamelo?atie* vestiging* afnamepunt* donorcentr* donatiecentr* “geen in de buurt” ~ 2 “geen dichtbij” ~ 2 “niet in de buurt” ~ 3 “niet dichtbij” ~ 3 onbereikba* “niet bereikbaar” afgelegen “te ver weg” “afstand groot” ~ 3 reistijd* gesloten Waitingtimes# wachttijd* “lange afnametijd*” wachtrij* “lange rij*” “wacht* lang” ~ 3 “was druk” ~ 3 “is druk” ~ 3 “een drukte” Openingtimes# opentingstijd* “tijd* veranderd” afnametijd “beperkt open*” “weinig open” “niet open” “beperkte tijd*” “alleen open” ~ 3 Nocall-up# “geen oproep” “niet opgeroepen” “nooit opgeroepen” “nooit oproep*” ~ 3 “geen uitnodiging” “geen kaart” “geen oproepkaart” “hoor niets meer” ~ 3 “niets meer gehoord” ~ 3 Sexualriskbehavior# HIV* “seks* risico*” “sex* risico*” homo* hetero* biseksue* transgender* “seks met” ~ 3 “sex met” ~ 3 MSM holebi “op man* val*” ~ 3 geaardheid “seksuele voorkeur” “met zelfde geslacht” ~ 2 “met hetzelfde geslacht” ~ 2 risicogroep risicogedrag “afrika* partner” “afrika* vrouw” “afrika* man” “oorspron* afrika*” ~ 2 Salaries# (salaris* jaarsalaris* maandsalaris* inkomen* loon maandloon jaarloon vertrekpremie* oprotpremie bonus* “geld verdienen” ~ 3 graai* directeur* directie* bestuur* manage* geldsmijt* gegraai* “rijk” verrijk* “ton” “tonnen” “balkenende norm” “wachtgeld” “grof geld” grootgraai* “hoge piet*” RvB “hoge beloning*” “ex-topman” geldwolv* “zakken vullen” “zakkenvullers”) NOT (vampi*) Timeconstraints# “weinig tijd” “beperkte tijd” “geen tijd”</p>

TABLE A3 Precision

	Precision
Voluntary	.62
Involuntary	.90
Anger	.84
Disappointment	.94
Donation location	.80
Lifestyle	.90
Medical	.98
No invitation	1.00
Opening times	.86
Physical reactions	.96
Pregnancy	.90
Remuneration	.80
Sexual risk behavior	.96
Time constraints	.62
Travels	.66
Waiting times	.70